101
42 4.1

(12) UK Patent Application (19) GB (11) 2 055 696 A

(21) Application No 8024499
(22) Date of filing
25 Jul 1980
(30) Priority data
(31) 79/26889
(32) 2 Aug 1979
(33) United Kingdom (GB)
(43) Application published
11 Mar 1981
(51) INT CL³ B41F 23/04
21/08
(52) Domestic classification
B6C 104 258 734 753
BAL
B8R 653 662 AJ4
(56) Documents cited
GB 1147363
GB 793216
(58) Field of search
B6C
F4G
(71) Applicant
Metal Box Limited
Queens House
Forbury Road
Reading RG1 3JH
Berkshire
England
(72) Inventor
William Alfred Nicholls
(74) Agents
Saunders & Dolleymore
2a Main Avenue
Moor Park
Northwood
Middx HA6 2HJ

(54) Sheet printing machine

(57) A printing system for metallic sheets (18) comprises a printing station; a curing oven (34) for curing ink applied to the sheets; and, below the curing oven, a cooling station (93). A key feature of the system is transfer apparatus (47) for transferring the sheets from edge-to-edge motion in one direction through the curing oven to face-to-face motion in the opposite direction through the cooling station. This apparatus comprises a transfer conveyor (48) defining a generally curved conveyor path (56) and having magnets to locate the sheets in the path. At a downstream end (72) of this path, the sheets are flung towards a slow-moving conveyor (74) of the cooling station, which has an overhead magnetic rail to hold the top edges of the sheets to the underside of the belt of the conveyor as they pass in spaced relation through the cooling station.

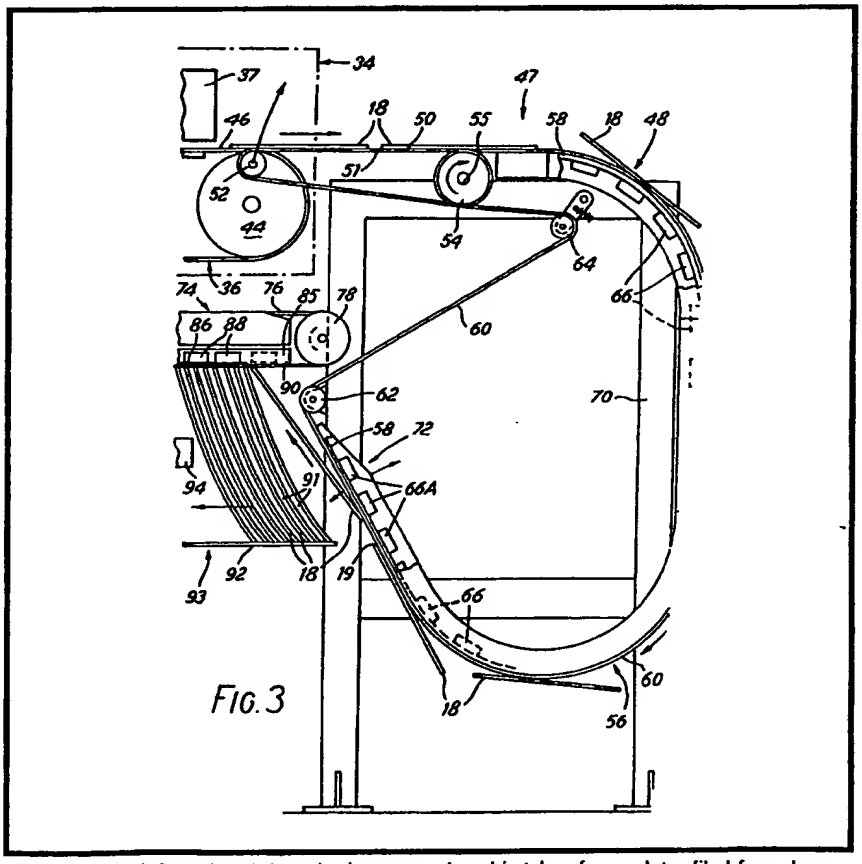

FIG. 3

GB 2 055 696 A

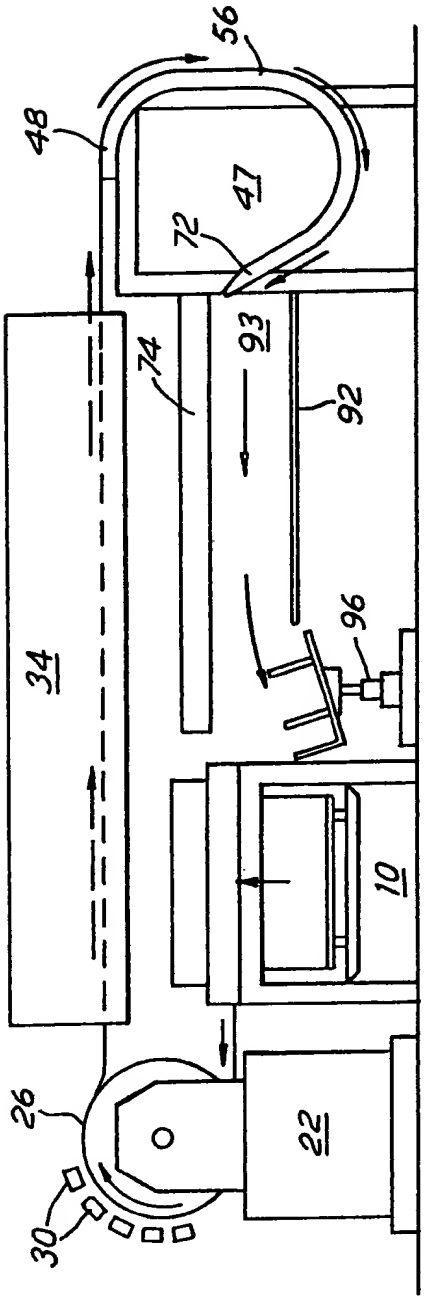

FIG. 1

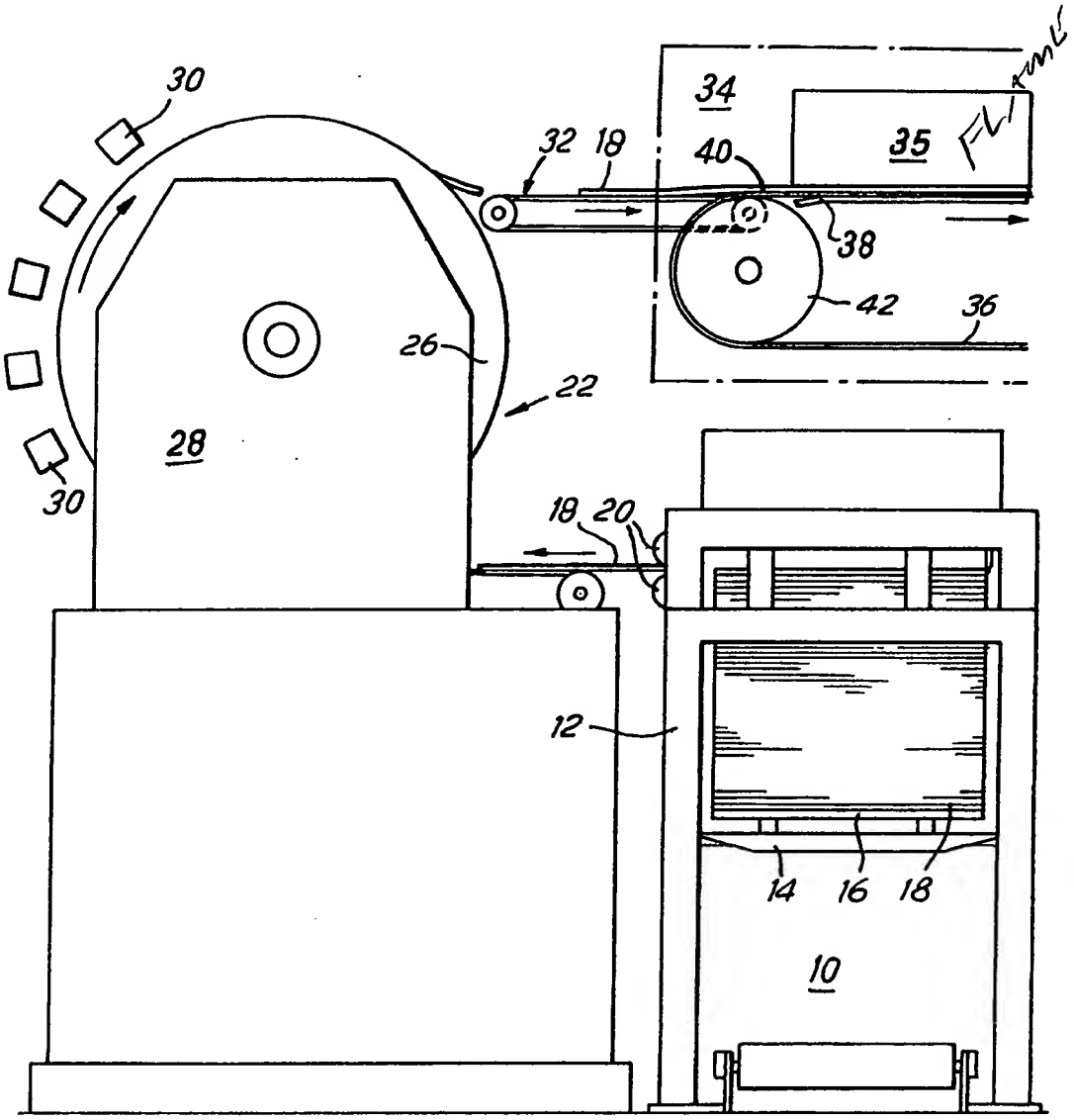

FIG. 2

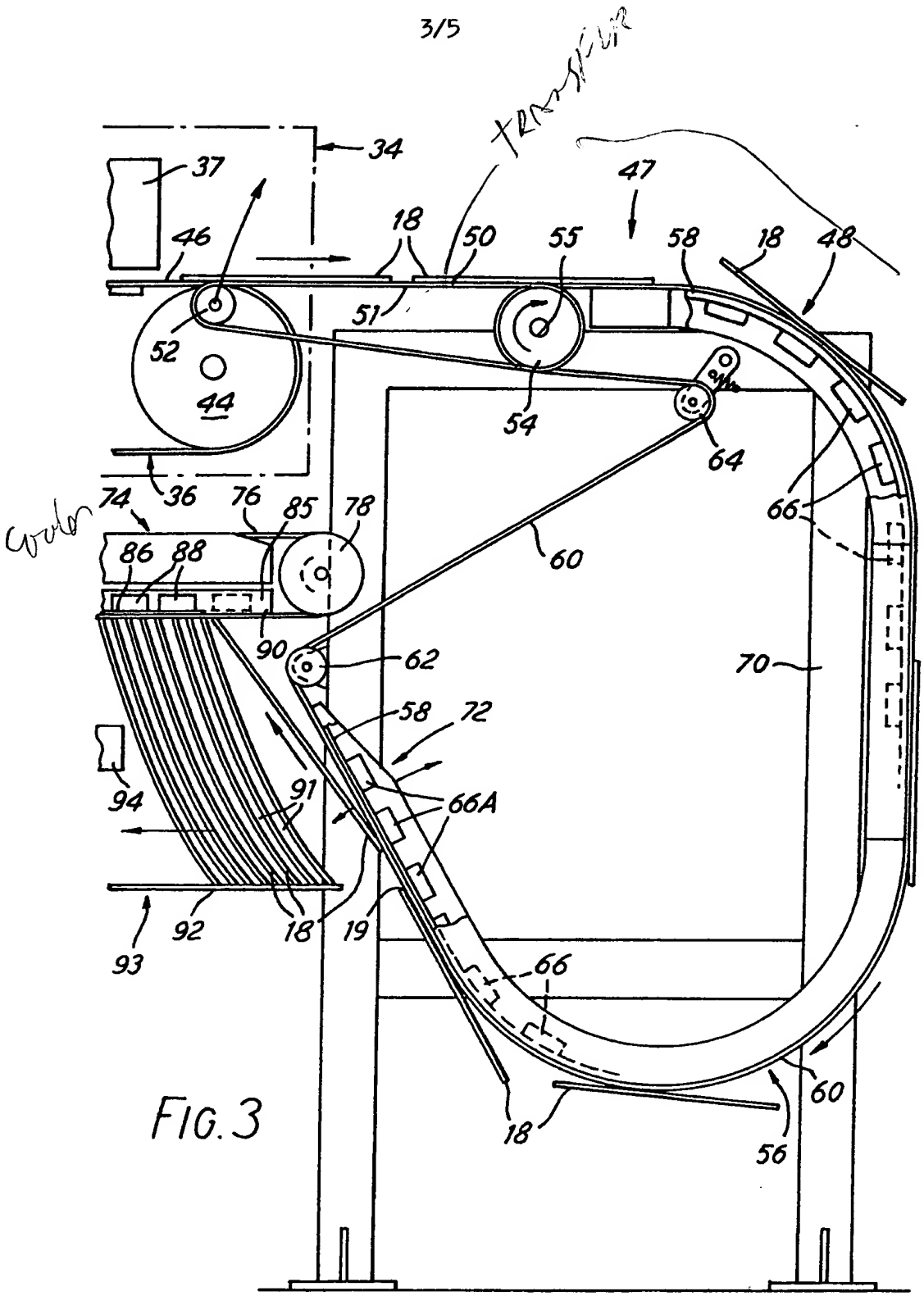
34
37
46
18
50
55
47
58
18
48
51
52
44
54
64
66
74
36
76
85
78
86
88
60
90
62
70
58
72
94
91
66A
92
18
19
93
66
18
56
60

FIG. 3

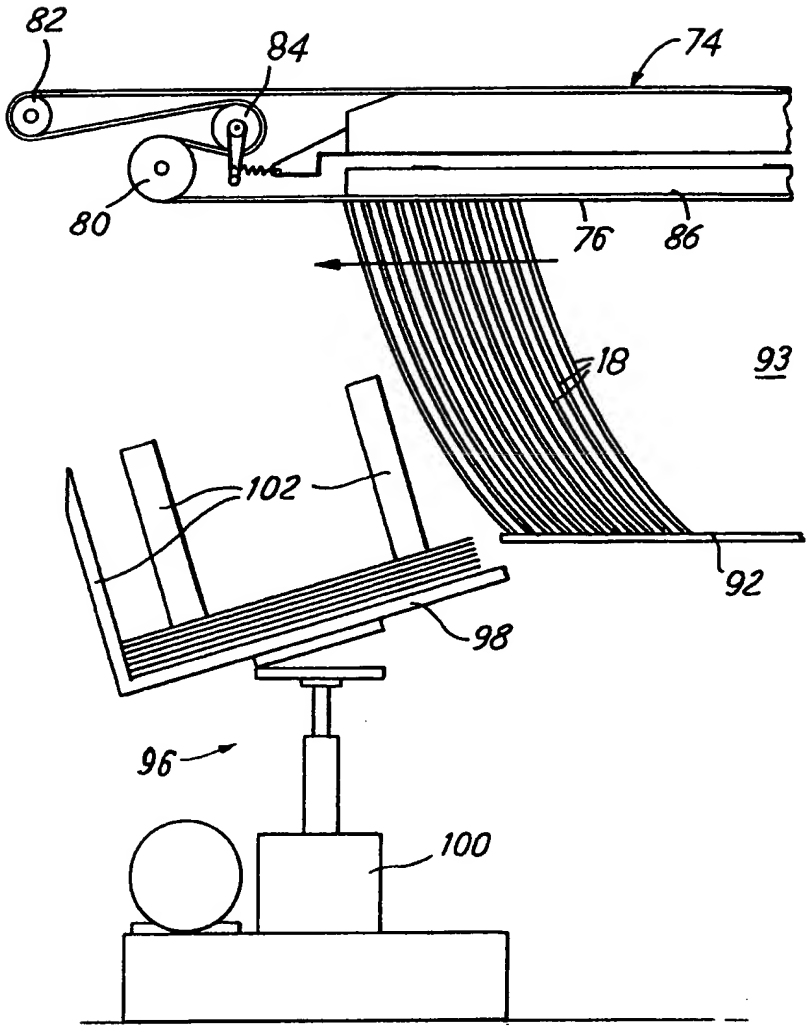

FIG. 4

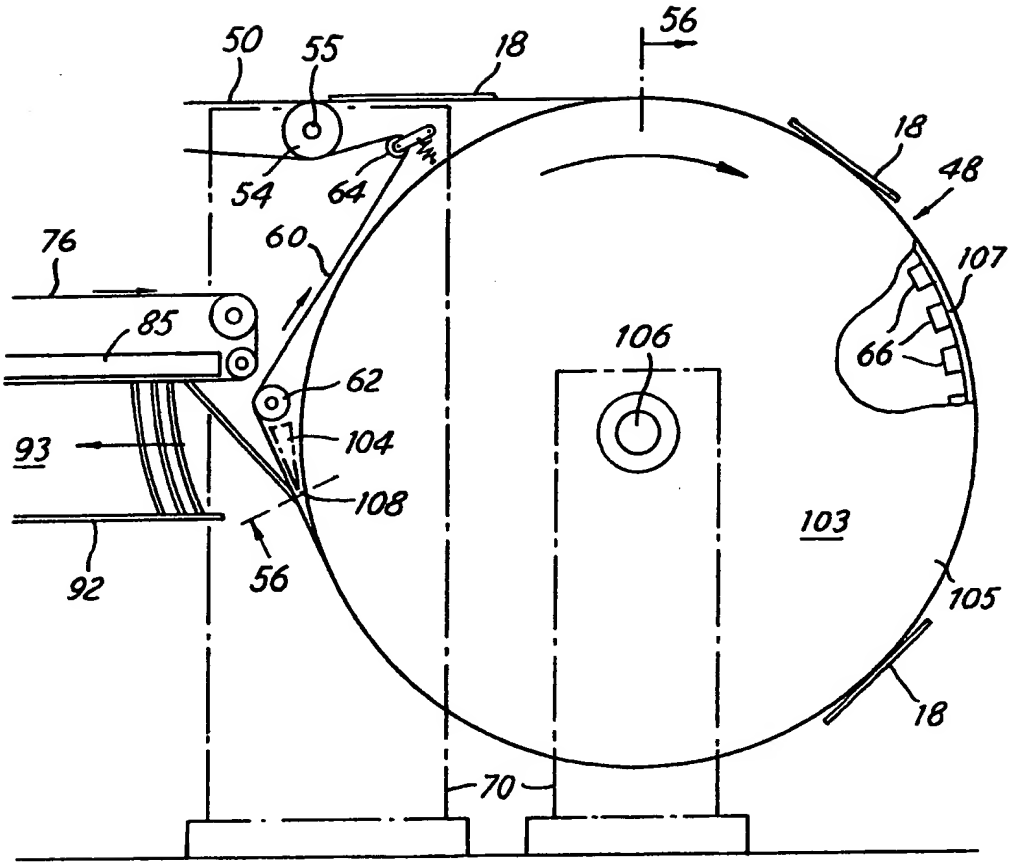
50
55
18
56
18
48
54
64
60
76
107
85
106
66
62
93
104
108
103
92
56
105
18
70

FIG. 5

SPECIFICATION

Sheet printing machine

TECHNICAL FIELD

This invention relates to transfer apparatus for sheets, particularly but not exclusively in connection with printing machines for printing sheets of metal or other non-limp material. It is also concerned with such printing machines *per se*.

BACKGROUND ART

In a known system for printing metal sheets, which may for example be used in the manufacture of can bodies or other items, printing ink is applied to the sheets as they are being conveyed in a horizontal plane by a first horizontal conveyor. This first conveyor feeds each sheet between a respective pair of wickets or oven trays secured to and upstanding from a second horizontal conveyor, and each sheet is then continuously advanced by the wickets, first through a heating station in the form of an oven for curing the ink, and then a cooling station where the sheet is cooled before being discharged from the wickets at a downstream end of the second conveyor on to a stack of printed sheets.

The printing ink application station, the oven and the cooling station are arranged in line with each other, with the result that they occupy extensive floor space. The wickets comprise metal lattices which provide support for the sheets whilst allowing air to circulate freely around the sheets in the oven and the cooling station. By virtue of the conductivity of the wickets, heating of the sheets in the curing oven to the correct temperature for curing the ink is delayed until the wickets themselves reach this temperature. Thus, besides being inefficient in the use of space, such a system is also wasteful of energy. Furthermore, in order to achieve a desired throughput of sheets, the second conveyor may have to have as many as 4,000 wickets. The initial expense of providing such a conveyor is coupled with considerable maintanance costs, since the wickets are prone to wear and damage and must be regularly replaced. The wickets are also closely spaced, so that the timing of the two conveyors is critical if the successive sheets are to be fed accurately between the wickets.

The use of a magnetic field to hold metallic articles on a conveyor is known. In one known arrangement, steel can ends are conveyed flat along a first conveyor to a magnetic roll which rotates the ends through approximately 90°. A stationary chute extending from an upper region of the roll receives the ends and allows them to accumulate on the chute in nesting relationship with each other. This arrangement, however, would be undesirable for the purpose of conveying printed metallic sheets through the heating and cooling stations of a printing system, since, on the one hand, excessive space would be required if the first conveyor were to extend through both stations, whilst on the other hand the chute (being stationary) would not serve to advance the sheets in the spaced relation which is required, by contrast with the can end stacker just mentioned, until the end of the cooling station is reached so as to facilitate cooling and to avoid scuffing or scratching of the printing ink.

One object of the present invention is to provide sheet transfer apparatus, having means providing a magnetic field to cause sheets of magnetisable material to follow a conveyor path, conveyor means arranged downstream of the path for advancing the sheets on edge and in face-to-face spaced relation, for example through a cooling station of a printing machine according to the invention.

A further object of the invention is to provide a printing system occupying less floor space than the system just described. Another object is to provide a compact transfer arrangement for use in such a system, for transferring sheets from the curing oven to the cooling station.

Another object is to provide sheet transfer apparatus which is suitable for use in a printing system in place of the abovementioned wicket-carrying further conveyor and which eliminates or reduces at least some of the disadvantages mentioned above.

A further object of the invention is to provide sheet transfer apparatus wherein magnetic fields or equivalent means are provided to support the sheets during a portion of their travel so that the number of moving parts in the apparatus may be reduced by comparison with the earlier apparatus (including the wicket-carrying type of conveyor).

Yet another object is to reduce the size and complexity of curing ovens by eliminating the use of wickets.

DISCLOSURE OF THE INVENTION

According to the invention in one aspect, the invention provides transfer apparatus for sheets, said apparatus comprising sheet-advancing means arranged continuously to advance the sheets in succession in edge-to-edge relationship along a predetermined path; conveyor means which are so spaced from an upwardly-inclined downstream end portion of the sheet-advancing means at the downstream end of said path that sheets arriving at said end of the path are carried therefrom by their own momentum towards the conveyor means, the conveyor means having means for locating the leading edges of the sheets thereon and support means for receiving the trailing edges of the sheets falling thereon, the conveyor means being arranged to advance the

sheets on edge, away from said end portion in spaced, face-to-face relationship.

In another aspect the invention provides a printing machine for sheets, comprising a printer; horizontally-extending ink-curing means for curing ink on the sheets by application of heat; cooling means below the ink-curing means; and transfer apparatus for transferring a succession of the printed sheets from the curing means to the cooling means, the curing means being arranged to operate with the sheets moving therethrough in a first direction in edge-to-edge relationship in substantially the same plane, and the transfer apparatus being adapted to turn the direction of motion of said sheets through an angle such that, upon transfer to the cooling means, one face of each sheet is facing in a second direction substantially opposite to said first direction, the cooling means having conveyor means for advancing the sheets in said second direction on edge, in spaced, face-to-face relationship.

This arrangement, wherein the cooling station is disposed under the heating station, permits considerable space savings to be effected; it may be achieved in a simple manner if the transfer apparatus of the invention is incorporated in the machine.

Advantageously, the curing oven can have a conveyor for carrying sheets through the oven substantially flat thereon, thus permitting direct flame curing, the sheets then being transferred to the cooling station by the transfer apparatus which preferably has magnetic means for holding the sheets as they are advanced to the cooling station. The conveyor of the cooling station may conveniently have magnetic means for locating the edges of sheets thereon.

Such apparatus has the advantage when used in a printing machine that less space and energy may be used for heating the sheets for curing the printing ink in the absence of wickets. Additionally, it is expected that elimination of the wickets will reduce both the initial and maintenance costs of the machine, the latter because the reduction in moving parts tends to cut down wear. A further advantage is that relative timing of the conveyors is less critical than when a feed conveyor has to feed the sheets between the closely spaced wickets of the oven conveyor.

It is also advantageous to arrange an elongate support below the sheet-locating conveyor surface of the cooling station conveyor, such that lower edges of sheets held by the latter are supported in compression with a slightly bowed configuration as the sheets are advanced through the cooling station. The sheets are thus prevented from swinging freely into, and so scuffing or scratching, one another, and can be held with a gas between each sheet and the next.

Embodiments of the invention are described in the Specific Description, by way of example only, with reference to the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

All the drawings are diagrammatic, with parts not essential to an understanding of the invention omitted for clarity. Like parts are given like reference numerals.

Figure 1 is a side elevation of a printing machine according to the invention.

Figure 2 is an enlarged elevation showing part of the machine.

Figure 3 is an elevation showing a transfer apparatus of the machine.

Figure 4 is an elevation showing the discharge end of the machine.

Figure 5 is an elevation showing an alternative form of transfer apparatus which may be used in place of that shown in Fig. 3.

SPECIFIC DESCRIPTION

The machine shown in Fig. 1, and to be described in greater detail with reference to the other Figures, is intended primarily for industrial application in the printing of small sheets of thin magnetisable metal (for example sheets of 60 cm. square) such as tinplate for use in the packaging industry.

The primary industrial application of the transfer apparatus shown in Fig. 3 or 5 is in a printing machine for small sheets as shown in the drawings. However it will be realised that such transfer apparatus may have many other applications where it is desired to translate the edge-to-edge relationship of a succession of sheets to a face-to-face relationship, particularly where the direction of motion of the sheets requires to be changed at the same time.

Referring first to Figs. 1 to 3, the machine includes a destacker 10 having a frame 12 which supports a vertically-movable table 14. In use, the table 14 carries a pallet 16 bearing a stack of metallic sheets 18. At an upper end of the frame 12, a pair of discharge rollers 20 are arranged for supplying the uppermost sheet 18 to a printer 22.

The printer 22 has an inlet conveyor 24 arranged to receive each sheet 18 from the rollers 20, and a rotary printing drum 26 mounted in a frame 28 to accept sheets from the inlet conveyor 24. The drum 26 is arranged to carry the sheets past ink applicators 30 and discharge them on to a feed conveyor 32 which extends between the printer 22 and a long, horizontally-extending curing oven 34.

A horizontal oven conveyor 36 has an upper stringer 38 passing through the oven 34 on a support plate 40. This conveyor comprises a pair of endless steel belts extending around an idle pulley 42 and a driven pulley 44. In the curing oven 34, for curing the ink on and removing solvent from the printed sheets heat from a flame burner unit indicated diagrammatically at 35 is directed

straight on to sheets 18 carried on the upper stringer 38 of the conveyor 36, whilst downstream of the burner unit, there is provided a heated air zone for blowing away solvent evaporated from the hot sheets by directing heated air at the sheets under pressure.

As shown in Fig. 3, the downstream end 46 of the oven conveyor 36 is arranged to discharge the sheets on to a transfer conveyor 48 of the transfer apparatus 47, by way of an intermediate conveyor 50 comprising steel belts 51 mounted on rotatable idle pulleys 52 and further pulleys 54 carried by a driven shaft 55. The transfer conveyor 48 follows a path 56 which is partly curved and partly straight in a vertical plane, and which turns through approximately 260°. The conveyor path 56 is at least partially defined by an elongate steel plate 58. Endless conveyor belts 60 are moved along the plate 58 by further pulleys 54 carried by the driven shaft 55, and extend around idle pulleys 62 and adjustable tensioning pulley 64. The belts 60 are driven by the pulleys on shaft 55 along the outside of the plate 58. Behind the plate 58, in relation to the belts 60, there is fixed a series of permanent magnets 66. These are mounted between a pair of fixed side supports 68 which also carry the plate 58 and which in turn are carried by a fixed frame 70 of the transfer apparatus. A magnetic field is thus created along the conveyor path 56 to hold the sheets 18 against the belts 60, thus causing the sheets to be carried around the path 56 by the latter. The magnets 66 are arranged along substantially the whole of the path 56. However, those in the upwardly-inclined final part 72 of the curved path 56, i.e. approaching the pulleys 62, are arranged to provide a magnetic field of diminished strength for reasons to be mentioned below. In the present instance, this is achieved by selecting appropriate permanent magnets 66A weaker than the magnets 66. However, an alternative possibility is to guide the belts 60 away from the plate 58 in the final or downstream end part of the conveyor path, i.e. in the end portion 72 of the conveyor 48, in which case the path 56 is defined initially by the plate 58 and finally by the belts 60 in the region where the latter depart from the plate 58.

The upwardly-inclined final part of the conveyor path 56 is directed towards the lower stringer 75 of a horizontal cooling station conveyor or cooler conveyor 74 which is arranged below the oven conveyor 36. The cooler conveyor 74 comprises a pair of endless steel belts 76 extending around driven pulleys 78, a pair of freely rotatable idle pulleys 80,82 and adjustable tensioning pulleys 84 (Fig. 4). The pulleys 78,80 are adjustable in a vertical direction (by means not shown), to alter the height of the lower stringer 75 as desired.

Also vertically movable so that the lower stringer 75 runs at all times along its lower surface, is a horizontal magnetic rail 85, typically comprising a flat steel plate 86 above which a series of permanent magnets 88 are fixed between a pair of fixed side supports 90 carrying the plate 86. The magnets 88 provide a magnetic field for holding the upper edges 19 of the sheets 18 leaving the transfer conveyor 48 against the lower stringer 75 of conveyor 74, so that the sheets are thereafter suspended from the cooler conveyor 74. A horizontal drag rail 92 spaced below the magnetic rail 85, serves to hold the sheets in compression, in slightly bowed form as seen in Fig. 3 and 4, against the rail 85 so that they cannot swing into and scratch or scuff one another and to preserve a gap 91 (typically of 2.5 cm) between each sheet and the next.

The cooler conveyor 74 passes through a cooling station 93. In the station 93, and mounted at a level intermediate between the magnetic rail 85 and the drag rail 92, is a blower (diagrammatically indicated at 94) or other suitable means for directing cooling air at the sheets 18 as they travel along the cooler conveyor 74. The air-directing means 94 are not, however, an essential part of the printing system since the sheets may sometimes be cooled in the station 93 merely by contact with the atmosphere during their advance by the conveyor 74.

Downstream of the conveyor 74, a stacking device 96 (Figs. 1 and 4) is arranged to receive the sheets 18. This device 96 comprises a table 98 mounted on a stand 100 and forwardly inclined to the horizontal, so that the rear, higher edge of the table is located adjacent to a downstream end of the rail 92. The latter terminates in advance of the magnetic rail 85 as seen in Fig. 4. The downstream end of the rail 85 thus lies above the table 98. As the sheets are advanced by the conveyor belts 76 beyond the magnetic rail 85, i.e. beyond the reach of the magnets 88, they fall forward on to the table 98. Upwardly-extending fingers 102 at a lower edge and sides of the table 98 serve to position the sheets on the table in a stack.

Operation of the machine illustrated in Figs. 1 to 4 is as follows:–

Plain tinplate sheets 18 are fed in succession from the top of the stack on the table 14 to the printing ink application station 22. Each sheet has ink applied by the applicators 30 to one of its faces at the station 22. The sheet is then passed at a comparatively high speed, printed face uppermost, through the curing oven 34 by the oven conveyor 36. Here the ink is cured, solvent being removed from the ink by the flame burners (which heat the sheets) and by the heated air blown on to the sheet. The still hot sheet is next carried by the transfer conveyor 48 at the same speed

towards the cooler conveyor 74 and the blower 94. As shown in Fig. 2, the sheet 18 is conveyed by the belts 60, with its unprinted face against the plate 58, along the path 56 and assumes a tangential relationship with the path where the latter is curved. The magnetic field provided by the magnets 66 holds the sheet 18 against the belts 60 as the sheet is carried thereby from the horizontal intermediate conveyor 50, around the path 56, until the sheet is upwardly inclined at the downstream end 72 of the path 56 with its upper edge 19 facing toward the cooler conveyor 74.

At this point, the sheet 18 continues to advance towards the conveyor 74 under its own momentum, the diminishing local magnetic field of the transfer conveyor 48, due to the weak magnets 66A, no longer determining the direction of motion of the sheet 18, which instead comes under the influence of the magnets 88. In other words, the sheet 18 is flung from the transfer conveyor 48 in the direction of the cooler conveyor 74. The relative positioning of the conveyors 48,74, and the speed of the belts 60, is selected to be such that the kinetic energy of the sheet leaving the transfer conveyor is mostly, but not quite entirely, converted into potential energy. Thus the leading edge 19 of the sheet just reaches the underside of the cooler conveyor 74 and is held against the belts 76 of the latter by the magnets 88. The reduced magnetic field provided by the magnets 66A at the downstream end of the path 56 allows the trailing edge of the sheet 18 to leave the path 56; and as the belts 76 of the cooler conveyor 74 advance the uppermost edge 19 of the sheet, its lowermost edge slides along the drag rail 92. The sheet is thus prevented from swinging into the sheet in front, the gap 91 being in this way maintained.

The sheet 18 is advanced by the belts 76 relatively slowly by comparison with the speed of the sheet on the oven and transfer conveyors 36,48, this being possible since the distance between one sheet and the next can be very much smaller when they are suspended face to face, as in the conveyor 74, than when they lie flat in edge-to-edge relationship as on the transfer conveyor 48. Thus, the conveyor 74 can achieve a similar throughput to the conveyor 36 with a much slower rate of advance. The sheet 18, whilst being advanced by the cooler conveyor 74, is cooled down as already mentioned, and is finally stacked on the preceding sheets by delivery on to the device 96.

Fig. 5 shows a large diameter wheel 103, in the form of a pair of identical discs 105 mounted on a rotatable shaft 107 which may be driven through suitable gearing by the main drive motor (not shown) of the machine. However, if as in the embodiment shown the belts 60 extend around the wheel 103, the wheel may freely rotate with the belts 60, the latter being driven as before by the pulleys 54 on the shaft 55.

The wheel 103 takes the place of the fixed plate 58 and its associated parts 68 shown in Fig. 3. The magnets 66 are located in the periphery of the wheel and all are of the same field strength. A cylindrical plate 107 may be provided about the rim of the wheel 103, the belts 60 bearing on the plate 107. The conveyor path 56 extends between the two arrows 56 in Fig. 5, and at the downstream end 108 of the path, the belts 60 are diverted by the pulley 62 away from the wheel 103, thus weakening the magnetic field due to magnets 66 exerted on the sheets 18 and enabling the latter to be flung as already described into engagement with the cooler conveyor 74.

Alternatively the pulley 62 may be omitted, the belts 60 then following the rim of the wheel 103 well beyond the point 108 (as indicated by a phantom line in Fig. 5). A fixed plough 104 may then be provided to divert each sheet 18 from contact with the wheel-type transfer conveyor 48 and towards the cooler conveyor 74.

In yet another alternative arrangement, the belt 60 may be omitted, the intermediate conveyor being extended so as to transfer the sheets direct on to the rim of the wheel 103, over a deadplate if necessary. The sheets will then be carried round in direct contact with the rim of the wheel until diverted therefrom by the plough 104 and flung by their own momentum towards the cooler conveyor 74.

It will be understood that in place of magnets, the transfer conveyor 48, in either of the embodiments described, may employ air suction in known manner. The magnets 88 of the cooler conveyor may be absent, the lower stringer of the belts 76 being provided with for example dogs against which the sheet edges 19 impinge as they are flung from the transfer conveyor. The lower edges of the sheets will then fall on to the rail 92 as before. In such an arrangement the sheets need not be of magnetisable material but may be of any non-limp material capable of being handled by the apparatus, for example relatively thick cardboard, non-magnetic metals, or certain plastics.

CLAIMS

1. A printing machine for sheets, comprising a printer; horizontally-extending ink-curing means for curing ink on the sheets by application of heat; cooling means below the ink-curing means; and transfer apparatus for transferring a succession of the printed sheets from the curing means to the cooling means, the curing means being arranged to operate with the sheets moving therethrough in a first direction in edge-to-edge relationship in substantially the same plane, and the transfer apparatus being adapted to turn the direction

of motion of said sheets through an angle such that, upon transfer to the cooling means, one face of each sheet is facing in a second direction substantially opposite to said first direction, the cooling means having conveyor means for advancing the sheets in said second direction on edge, in spaced, face-to-face relationship.

2. A machine according to Claim 1, wherein the transfer apparatus comprises sheet-advancing means arranged continuously to advance the sheets in succession in edge-to-edge relationship along a predetermined path, the conveyor means of the cooling means being so spaced from an upwardly-inclined downstream end portion of the sheet-advancing means at the downstream end of said path that sheets arriving at said end of the path are carried therefrom by their own momentum towards the conveyor means, the conveyor means having means for locating the leading edges of the sheets thereon and support means for receiving the trailing edges of the sheets falling thereon, the conveyor means being arranged to advance the sheets on edge, away from said end portion in spaced, face-to-face relationship.

3. A machine according to Claim 1 or Claim 2, wherein the conveyor means of the cooling means is arranged to move the sheets at a forward velocity substantially less than that of their movement when in said edge-to-edge relationship.

4. A machine according to any one of Claims 1 to 3, wherein the printer comprises a printing drum arranged to carry the sheets in succession past a plurality of ink applicators situated about the circumference of the drum.

5. A machine according to any one of the preceding claims, wherein the curing means has direct flame-impingement means and hot air means for removing solvents from ink on the sheets.

6. A printing machine for sheets, constructed, arranged and adapted to operate substantially as hereinbefore described with reference to, and as illustrated in, Fig. 1 of the drawings hereof.

7. A printing machine according to Claim 6, constructed, arranged and adapted to operate substantially as hereinbefore described with reference to, and as illustrated in, Figs. 2 to 4 of the drawings hereof.

8. A printing machine according to Claim 6, constructed, arranged and adapted to operate substantially as hereinbefore described with reference to, and as illustrated in, Figs. 2, 4 and 5 of the drawings hereof.

9. Transfer apparatus for sheets, comprising sheet-advancing means arranged continuously to advance the sheets in succession in edge-to-edge relationship along a predetermined path; conveyor means which are so spaced from an upwardly-inclined downstream end portion of the sheet-advancing means at the downstream end of said path that sheets arriving at said end of the path are carried therefrom by their own momentum towards the conveyor means, the conveyor means having means for locating the leading edges of the sheets thereon and support means for receiving the trailing edges of the sheets falling thereon, the conveyor means being arranged to advance the sheets on edge, away from said end portion in spaced, face-to-face relationship.

10. Apparatus according to Claim 9, wherein said predetermined path is at least partly curved, the sheet-advancing means comprising a sheet-engaging member arranged to move along said path and holding means for drawing the sheets into continuous engagement with the sheet-engaging member.

11. Apparatus according to Claim 10 for sheets of magnetisable material, wherein the holding means comprises magnet means.

12. Apparatus according to any one of Claims 9 to 11, wherein the conveyor means comprises an elongate sheet-engaging member intercepting the path of a sheet carried by its own momentum from the sheet-advancing means at the said end portion, the locating means being associated with the said elongate sheet-engaging member for holding the leading edge against the latter.

13. Apparatus according to any one of Claims 9 to 12, wherein the sheet-advancing means has, at its upwardly-inclined downstream end portion, means adapted to reduce the constraint on the sheets to follow said path, whereby the sheets are free to continue towards the conveyor means under their own momentum.

14. Apparatus according to Claim 13, in which the sheet-advancing means comprises a sheet-engaging member arranged to move along said path and holding means for drawing the sheets into continuous engagement with the sheet-engaging member, characterised in that the holding means at the said end portion is arranged to exert a reduced force on the sheets as compared with the holding means of the remainder of the sheet-advancing means whereby to reduce said constraint at the end portion.

15. Apparatus according to Claim 14 for sheets of magnetisable material, wherein the holding means comprises magnet means.

16. Apparatus according to Claim 15, wherein the magnet means are fixed with respect to said path, the magnet means at the downstream end portion being weaker than the magnet means associated with the remainder of said path.

17. Apparatus according to Claim 15, wherein the sheet-engaging member is so disposed at the end portion that the sheet-engaging member is diverted away from the holding means as it moves along the end portion, so as to reduce the force exertable on

the sheets by the holding means.

18. Apparatus according to any one of Claims 9 to 17, for sheets of magnetisable material, wherein the locating means includes magnet means.

19. Apparatus according to Claim 18 wherein the elongate sheet-engaging member is endless, the locating means being a magnetic rail extending along and above a lower stringer of the endless member.

20. Apparatus according to any one of Claims 9 to 19, wherein the distance between the elongate sheet-engaging member and the support means is less than the distance between the leading edge and the trailing edge of a sheet, so that each sheet when engaging both the sheet-engaging member and the support means is held in compression and in slightly bowed configuration therebetween.

21. Apparatus according to Claim 10, or Claim 10 and any one of Claims 11 to 20, wherein said predetermined path extends through an angle from the initial direction of motion of the sheets such that the direction of advance of the sheets by the conveyor means is substantially reversed with respect to said initial direction.

22. Apparatus according to Claim 21, wherein the sheet-advancing means has a substantially horizontal upstream end for receiving the sheets in a substantially horizontal initial direction of motion,the conveyor means extending substantially horizontally.

23. Apparatus according to Claim 21 or Claim 22, wherein the said angle is 260°.

24. Apparatus according to any one of Claims 21 to 23, wherein the sheet-advancing means is arranged at the delivery end of further conveyor means for delivering the sheets in a generally-horizontal direction, the conveyor means of the transfer apparatus being disposed below said further conveyor means.

25. Apparatus according to any one of Claims 10 or 21 to 24, wherein the sheet-engaging member of the sheet-advancing means is an endless conveyor member, the sheet-carrying means comprising also fixed guide means, means for locating the conveyor member so as to follow said path and means for driving the conveyor member around the fixed guide means, the holding means being carried by the fixed guide means behind the conveyor member.

26. Apparatus according to any one of Claims 10 or 21 to 24, wherein the sheet-advancing means comprises a rotatable wheel whose circumference defines at least the greater part of said predetermined path, the holding means being incorporated in said wheel and the apparatus further having diverting means at the downstream end of the path adapted to reduce the constraint on the sheets to follow said path, whereby the sheets are caused to continue towards the conveyor means under their own momentum.

27. Apparatus according to Claim 26, wherein said wheel comprises a pair of substantially identical discs whose peripheries together define the said path.

28. Apparatus according to Claim 26, wherein the diverting means comprise a fixed plough member.

29. Apparatus according to Claim 26 for sheets of magnetisable material, wherein the diverting means comprise magnet means of the conveyor means, the said magnet means bein so disposed as to exert a greater attractive force on the sheets at the downstream end of the said path than the holding means of the rotatable wheel.

30. Apparatus according to Claim 26, wherein the sheet-engaging member of the sheet-advancing means is an endless conveyor member which extends around and in contact with that part of the periphery of the wheel which defines the said path.

31. Apparatus according to Claim 30, wherein the conveyor member is arranged to move away from the wheel at the downstream end of said path so as to divert the sheets away from the influence of the holding means.

32. Apparatus according to any one of Claims 9 to 31, wherein the conveyor means is arranged to move the sheets substantially more slowly than the sheet-advancing means.

33. Transfer apparatus for sheets, constructed, arranged and adapted to operate substantially as hereinbefore described with reference to, and as illustrated in, Fig. 3 of the drawings hereof.

34. Transfer apparatus for sheets, constructed, arranged and adapted to operate substantially as hereinbefore described with reference to, and as illustrated in, Fig. 5 of the drawings hereof.

Printed for Her Majesty's Stationery Office
by Burgess & Son (Abingdon) Ltd.—1981.
Published at The Patent Office, 25 Southampton Buildings,
London, WC2A 1AY, from which copies may be obtained.